

## **Trap Alignment and Initial Calibration**

The focus of this optical trap instrument is not individual construction by undergraduate students, but a focus on the function, calibration, and experiments of an optical trap. Thus, construction and alignment of the instrument is optimally performed by someone with a familiarity with optics; however, a skilled undergraduate with some instruction can assemble and calibrate an instrument in a limited amount of time (~12-24 hours). Once constructed, the optical trap can be used for multiple laboratory sections with a minimum of upkeep or realignment due to drift.

We suggest aligning the trapping laser through the center of the objective and condenser holders first (making sure that these two pieces are aligned concentrically on the mounting post beforehand). A useful method is to get the beam parallel to the breadboard and perpendicular to the brightfield imaging path with the two steering mirrors, then aligning the beam through the objective and condenser holders using the 45° mirror and dichroic. Finally the telescope optics for expansion can be mounted and the alignment verified. The position of the trap can be visualized with the camera, and a bead solution (define) can be introduced as the sample to determine if the trap is formed at the appropriate position (x,y, & z) as desired. Adjustment of the trap position in z can be accomplished by changing the distance between telescope lenses. Fine alignment of the trap beam through the objective and condenser can be obtained by manipulation of the dichroic mirror and the horizontal and vertical position of one of the telescope lenses.

The position detection branch can be aligned by first setting and marking the condenser height which produces a collimated beam of the trapping laser. The condenser should remain (or always return to) this height when making measurements. The 45° dichroic mounted in the cage above the condenser is used for coarse positioning of the beam on the QPD. The QPD should be mounted conjugate to the back focal plane, easily where the aperture of the condenser is imaged. Fine alignment of the QPD is accomplished by watching the detection signal in X & Y, and zeroing the signal with no objects in the trap using fine adjustment of horizontal and vertical positioning of the QPD in the mount.